



IRRIGATION TRAINING AND RESEARCH CENTER  
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## ITRC Weir Stick

Irrigation districts, farmers, and other agricultural and environmental water users need reliable and low-cost flow rate measurement methods to quickly and easily measure the flow rate over weirs. The Irrigation Training and Research Center (ITRC) has developed a new weir rule for open-channel flow rate measurement. Funding for the research of this new device was sponsored by the United States Bureau of Reclamation - Mid Pacific Region office. This weir rule is based on the same hydraulic principles as a Clausen weir rule, except that the operation of the ITRC weir stick has been simplified by adjusting its scale. This new instrument is expected to quicken and ease flow rate measurement in the field, while providing accurate results for water/irrigation districts and consumers.



**Figure 1. Using the ITRC weir stick to clear weeds in front of a weir.**



**Figure 2. Front view of ITRC Weir Stick being placed on the top of a check for a flow rate measurement.**

### Design

The ITRC weir stick is founded on the principles of open-channel hydraulics. Fluids flow in response to a change in energy, so a liquid flows through an open-channel, it possesses three forms of energy that are termed “head”: elevation head, pressure head, and velocity head. Measurement tools developed with time and research measure this energy, and this reading can be related to the flow rate in that channel. One instrument developed to measure the flow rate is the Clausen weir rule.

This rule requires a weir (preferably a sharp crested weir or flashboards) for the measurement site. When first measuring the water level, or head, across the weir, the water rises to a higher elevation on the stick than the surrounding water. The “run-up on the stick”, as it is often called in industry, is the velocity head. Normally, the velocity head complicates the flow rate calculation, and also requires a second measurement to be taken at the same location. A weir rule directly measure the velocity head and eliminates the need for additional measurements.

The ITRC weir stick has been created through calculations, design, and testing, to measure the flow similar to the simple Clausen weir rule, but in just one measurement. It also has been designed to set and pull boards.

The ITRC weir stick is based on a set of criteria:

1. a broad-crested weir or flashboards for the measurement location
2. a **suppressed**, rectangular weir
3. free-flow (i.e., no submergence)

Under these conditions, the equation for the weir rule was determined as:

$$q = 3.3 \times H^{1.5}$$

where:

$q$  = CFS/ft of weir width, measured by the reading on the weir rule

$H$  = Head, in feet scale for the weir rule was developed based upon the above equation, shown as varied graduations that begin as large increments and gradually decrease with increasing height.

After developing the scale for the weir rule based on this equation, the flow rate through the open-channel can be ascertained by:

$$Q = q \times b$$

where:

$Q$  = flow rate of channel, in CFS

$q$  = CFS/ft of weir width, measured by the reading on the weir rule

$b$  = weir width, in ft

This equation takes the form of a **suppressed rectangular** weir equation. To compensate for contracted weirs, angled weirs, and submerged flow over the weir use the following multipliers:

Multiply the measured flow rate per foot by the corresponding multipliers below					
Contracted		Submergence		Angled	
Head (ft)	Multiplier	Submergence Ratio	Multiplier	Weir Angle from Horizontal	Multiplier
0	1.00	0	1.00	90 (std. weir)	1.000
0.1	0.98	0.1	0.99	80	1.050
0.2	0.96	0.2	0.96	70	1.080
0.3	0.94	0.3	0.93	60	1.105
0.4	0.92	0.4	0.89	50	1.110
0.5	0.90	0.5	0.84	40	1.115
0.6	0.88	0.6	0.78	30	1.060
0.7	0.86	0.7	0.70	16	1.080
0.8	0.84	0.8	0.59		
0.9	0.82	0.9	0.44		
1.0	0.80	0.99	0.14		
1.1	0.78				
1.2	0.76				
1.3	0.74				
1.4	0.72				
1.5	0.70				

**Table 1. Multipliers for calculating the flow rate over various types of weirs**



**Figure 2. Using the ITRC Weir Stick to pull boards**

## Operation

When a measurement location has been determined, the weir rule must be dipped into the water. Afterwards, a layer of fine soil dust is sprinkled onto the rule. The finer the texture of the soil dust, the better the accuracy of measurement. The angle iron base of the rule is then set on top of the flashboard at the center of the canal width. The rule must be flush with the flashboard. After water has washed away part of the dust layer, the rule is removed. The highest reading of the “washed away” area is the correct head measurement. Multiplying this number by the canal width (in feet) yields the flow rate of that reach of the canal.



**Figure 2. Reading a small flow rate using the ITRC Weir Stick on a spill site**

## Summary

The ITRC Weir Stick is an easy, low-cost measuring device to quickly measure the flow rate over various types of weirs. It can easily be implemented into any flow measurement procedure.

The unit cost is under \$100. Batch orders will be processed by the ITRC.

## Sponsored By

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